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(71) Applicants
Showa Denki Kogyo Co., Ltd.,
7—3, Higashishinbashi 2 chome, Minato-ku,
Tokyo 105, Japan
(72) Inventor
Takeo Hoshina
(74) Agent
Herbert J. W. Wildbore,
52/54, Featherstone Street, London, EC1Y 8ST

(54) **Heated pipeline**

(57) Crude oil or other viscous fluid is transported in cold locations by a pipe-line consisting of an outer protective pipe 2 and an inner oil-conveying pipe 1, said pipes being made of a ferromagnetic material and connected to a source 4 of A.C. current at one end to generate heat, the inner pipe having a covering 7 of an electric and heat-insulating material and the outer pipe being covered by a concrete layer 8.

FIG. 2

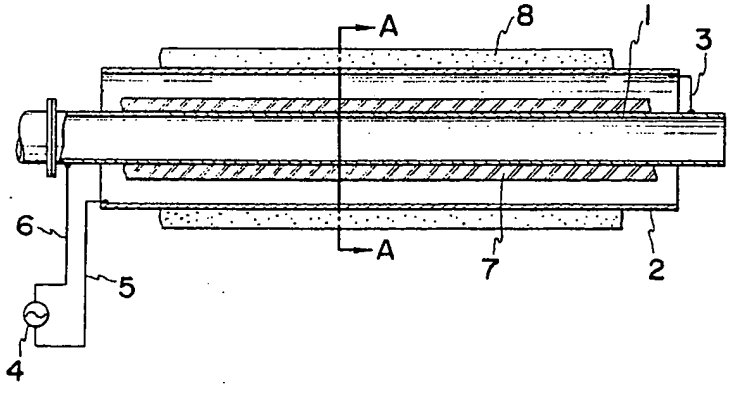

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FIG. 1

FIG. 2

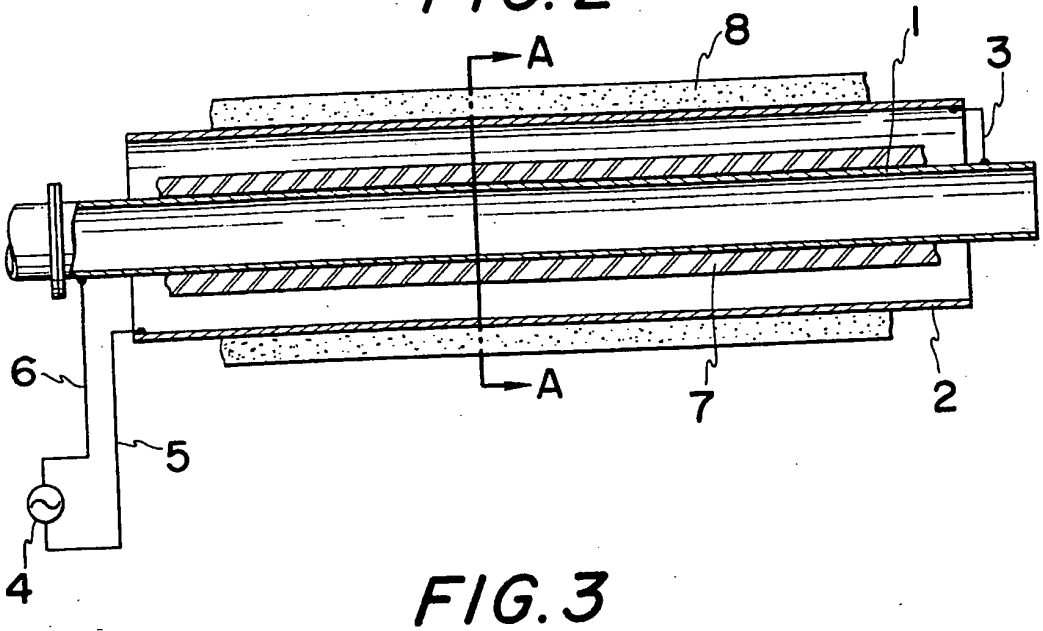
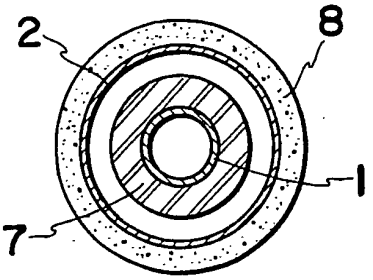


FIG. 3



SPECIFICATION

Method of transporting crude oil by a pipe line

The present invention relates to a method of and means for transporting crude oil, particularly through locations of low temperature such as at the sea bottom or in cold districts.

The transportation of crude oil is usually made through pipe lines or ocean-going tankers. From the point of view of transportation cost, the use of a pipe line is preferred to that of an ocean-going tanker. In case of a long-distance transportation or transportation in a cold district, it is necessary to provide various installations along the pipe line for heating the pipe to maintain a substantially constant viscosity of the crude oil to ensure flow under transportation. This inevitably incurs a rise in the cost of the construction of the pipe line.

On the other hand, a considerable reduction of transportation cost is possible if tankers, which now share most part of the sea transportation of crude oil, are substituted by a pipe line. The aforementioned problem, however, will occur also in such a transportation that require the off-shore installations for heating the pipe, resulting in an increased construction cost.

It is, therefore, an object of the invention to provide a pipe line which can be laid at a low cost, thereby to overcome the structural problem of the conventional heated pipe line which involves a high construction cost.

A second object of the invention is to provide a pipe line which results in the viscosity of the crude oil being kept sufficiently low and therefore capable of being smoothly transported even in a location of low temperature such as at the sea bottom or in cold location.

A third object of the invention is to provide a pipe line that is not adversely affected by changing prevailing conditions, e.g. temperature and water pressure and therefore capable of ensuring a stable and safe transportation of crude oil over a long period, e.g. several decades.

According to this invention, there is provided a pipe line having a double-pipe structure constituted by an inner and an outer pipe, the inner and outer pipes being electrically connected in series, and means for applying A.C. current directly to these pipes to generate heat according to Joule's law to heat up said pipes.

Preferably, the outer pipe is so constructed that it effectively protects the inner pipe against water pressure, corrosion or the like, while the inner pipe directly heats and transports the crude oil, so that the crude oil can be stably and safely transported along the sea bottom.

To enable the invention to be clearly understood and readily carried into effect, a preferred embodiment thereof will now be described by way of example with reference to the accompanying drawings, wherein:—

Figure 1 diagrammatically illustrates a pipe line embodying the present invention, applied to transportation of crude oil along the sea bottom;

Figure 2 is a longitudinal cross section of a crude oil transportation pipe line and its heating system constructed in accordance with the invention; and

Figure 3 is a transverse cross section taken on the line A—A of Figure 2.

Referring to said drawings, the present invention makes use of a phenomenon that a ferromagnetic material generates heat by itself without requiring any specific heating equipment. Namely, according to the invention, the pipes constituting the pipe line are made of a ferromagnetic material so that the pipes generate heat by themselves to eliminate the necessity for specific heating equipments.

Figure 1 illustrates a sea-bottom pipe line for transporting crude oil constructed in accordance with the invention. As will be seen from Figure 2, the pipe line indicated at *a* in Figure 1 is constituted by an inner steel oil-transportation pipe 1 made of a ferromagnetic material and an outer protective steel sheath pipe 2 also made of a ferromagnetic material and surrounding the oil-transportation pipe 1. The transportation pipe 1 and the sheath pipe 2 are electrically connected to each other at their ends as at 3. A.C. electric current is supplied from a power source 4 to the transportation pipe 1 through a wire 6. The A.C. current is further supplied to the sheath pipe 2 through the transportation pipe 1 and the connection 3, and is returned to the power source 4 by way of the wire 5.

An electric and heat insulating layer 7 covers the outer surface of the oil-transportation pipe 1, while a concrete layer 8 covers the outer surface of the sheath pipe 2 when the pipe line is used for the sea-bottom transportation of the crude oil.

The pipe line *a* is laid in the following manner. Pieces of sheath pipe 2 of suitable length are welded in series successively and placed on the sea bottom complete with the concrete layer 8. Then, pieces of oil-transportation pipe 1 of suitable length are welded in series and inserted into the sheath pipe 2, while being clad by the electric and heat insulating layer 7. Finally, the transportation pipe 1 and the sheath pipe 2 are electrically connected at their ends.

Crude oil is transported from a station 9 to a station 10 as shown in Figure 1, through the transportation pipe 1 of the thus laid pipe line *a*, by means of a pump. During the transportation, as A.C. current is supplied to the transportation pipe 1 from the power source 4, the transportation pipe 1 generates heat due to its A.C. current characteristic (resistance loss and iron loss) to heat the crude oil flowing therethrough to lower the viscosity of the oil so that friction or drag impeding flow of the crude oil is kept to a minimum. The A.C. electric current is further supplied to the sheath pipe 2 to generate heat in the latter due to the same reason, so that the space in the sheath pipe 2 is heated to preserve the temperature of the transportation pipe 1 to protect the latter from the influence of the low temperature at the sea bottom.

The pipe line for sea-bottom transportation of

crude oil in accordance with the invention offers the following advantages.

(1) The pipe line has a double-pipe structure constituted by the inner oil-transportation pipe 1 and the outer sheath pipe 2 which are electrically connected in series, so that heat is generated in these pipes as they are supplied with A.C. electric current due to their A.C. current characteristics. Therefore, electric wires or the like cables are completely eliminated from the pipe line *a*, except at the ends so that the pipe line *a* is completely free from electrical troubles due to secular change and can easily be maintained after the installation.

(2) Since the heat is generated not only in the transportation pipe 1 but in the sheath pipe 2 as well, the temperature of the crude oil is effectively preserved with minimum heat loss.

(3) The sheath pipe 2 completely surrounding the transportation pipe 1 effectively prevents the release of crude oil into ambient sea water, even in the case of a leak from the oil-transportation pipe 1. This features is quite advantageous from the view point of safety countermeasure.

(4) For laying the pipe line, the sheath pipe 2 is welded and successively pushed into sea water and then the welded transportation pipe 2 is progressively inserted into the sheath pipe 2 together with the electric and heat insulating covering layer. Thus, all of the work necessary for laying the pipe line can be conducted ashore.

(5) The pipe line of this invention may advantageously be used not only for the sea-bottom transportation of crude oil but also for other purposes such as sea-bottom and land transportation of other viscous fluids, as well as transportation of these materials in cold locations.

CLAIMS

1. A method of transporting crude oil or other viscous fluid in cold locations by a pipe-line that consists in using a pipe-line having a double-pipe structure constituted by an inner and an outer pipe, the inner and outer pipes being electrically connected in series, and means for applying A.C. current directly to these pipes to generate heat according to Joule's law to heat up said pipes.

2. A pipe-line for carrying out the method claimed in Claim 1, wherein said inner and outer pipes are made of a ferromagnetic material.

3. A pipe-line as claimed in Claim 2, wherein the outer pipe is so constructed that it effectively protects the inner pipe against water pressure, corrosion or the like while the inner pipe directly heats and transports the crude oil, so that the crude oil can be stably and safely transported along the sea bottom.

4. A pipe-line according to Claim 2 or 3, wherein the inner oil-transporting pipe is covered by an electric and heat-insulating material.

5. A pipe-line according to Claims 2, 3 and 4, wherein the outer surface of the outer pipe is covered by a concrete layer.

6. A method of transporting crude oil or other viscous fluid by a pipe line characterised by the use of a pipe line of a double pipe structure comprising in combination an oil-transportation pipe and made of a ferromagnetic material and a sheath pipe surrounding said transportation pipe and electrically connected at one of its ends to the end of said transportation pipe, said sheath pipe being also made of a ferromagnetic material, said transportation pipe being adapted to be supplied with A.C. electric current which is returned to an electric power source through said sheath pipe, so that heat is generated in said transportation pipe and said sheath pipe to heat said crude oil flowing through said transportation pipe to lower the viscosity of said crude oil so that friction or drag impeding flow of the crude oil is kept to a minimum.

7. A method of and means for transporting crude oil or other viscous fluid substantially as hereinbefore described and constructed as illustrated by the accompanying drawings.

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